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The discussers congratulate the author for his clear and concise description of the closure problem applied to jet scour in plunge pools. The set of equations has been solved by assuming that the drag forces exerted by the fluid on the bed particles are correlated with the near bed velocity u_b and the Chézy roughness coefficient. The former is defined as a function of jet shape at impact, the approach flow jet velocity U_1, jet thickness b_1 and a coefficient α. Using Shields criterion, a critical shear stress is defined for the bed, which finally allows computing the maximum scour depth.

Although several qualitative criteria for turbulence effects on the initiation of particle movement have been studied in the past and are introduced in the author's approach, his procedure strictly retains a quasi-steady character and no real turbulence effects are incorporated by means of physical parameters. Also, quasi-steady drag forces on rock blocks depend on the local block shape when compared with its surroundings, which is difficult to define. As such, the discussers have the following questions regarding the accuracy and application of the author's approach:

1. Which Ψ values had to be used (calibrated) to match the theoretical model with both laboratory and prototype scour data? Were these values consistent?
2. Several α factors are integral part of the model equations. What is the global error on the estimates of these parameters and what would be the effect of this global error on the scour depth estimate?
3. A real jet is rarely plane or circular. The bottom velocity depends directly on the jet shape at impact. Based on Bohrer *et al.* (1998), the jet velocity decay strongly depends on the degree of jet development in the air. What are their errors on the scour depth?

Furthermore, the author correctly states that his method also works if the effects of fluctuating pressure and the rock characteristics are included. The discussers would like to state major difficulties in doing this, including the following:

1. The unknown G was determined by assuming the scour hole shape, which may become invalid if applied to a real rock mass, with complex 3D fracture patterns that often result in complex scour hole shapes.
2. The use of a critical block stability factor accounting for quasi-steady and turbulent forces that act on a rock block in a plunge pool is complicated to solve. Block stability depends not only on these near the pool bed (Bollaert and Hofland 2004) and the geo-mechanical characteristics of the rock mass, namely block shape, height, side length, density or fissure orientation to the flow, but also on the direct interaction between turbulence and the rock mass characteristics.

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The latter generally change with depth inside a scour hole. The number of relevant parameters and equations increases therefore significantly and a generic analytical solution to the problem seems *a priori* challenging.

Note that the second aspect is actually being studied at the Laboratory of Hydraulic Constructions (LCH) of the Swiss Federal Institute of Technology (EPFL) by means of prototype-scaled measurements of pressure fluctuations around an artificial rock block due to high-velocity jet impingement. Both the instantaneous block movements (displacement, acceleration) and the turbulent pressure field around the block are recorded at high frequencies, allowing for a better understanding of the mechanisms responsible for block ejection (Federspiel *et al.* 2009).

Further, the discussers would like to provide thoughts regarding the air influence on scour depth. The author states that works in literature follow the same trend as his theoretical model, i.e. a decrease in scour depth with increasing air concentration. At the same time, his Eq. (15) omits this effect because it should be negligible as compared to the influence of the D_{90} term in the equation. Also, when applying the model to the databank, no air concentration values are mentioned. Does this mean that his model is unable to specify this effect and that the potential error on the various α factors is much more important?

Furthermore, Canepa and Hager (2003) used a small laboratory scale, which, in the discussers' opinion, does not allow quantifying nor qualifying air entrainment effects on scour formation. Mason (1989) found an increase im scour depth with increasing air entrainment instead of a decrease, as stated by the author, in contradiction with the assumptions presented by the author.

The discussers' work performed at LCH indicated the importance of the scale of the problem (Bollaert 2002, 2003, Bollaert and Schleiss 2003, Manso *et al.* 2006, Bollaert *et al.* 2009). Prototype-scaled air concentration measurements of high-velocity jet impact in an artificial plunge pool have shown that the air concentration at the rock bed seems to be related to a pressure built-up as the stagnation point is approached resulting in a sudden pressure decrease following radial jet deflection. Applying the ideal gas law, $pV^n = mRT =$ constant, in which $p =$ pressure, $T =$ temperature, $R =$ thermodynamic constant, $m =$ mass of the gas moles in a given volume V and $n =$ constant depending on the type of thermodynamic process ($n = 1$ for adiabatic process), the volume reduction ΔV of a given mass of air is inversely proportional to the rise in absolute pressure Δp. The amount of air does not change, yet the bubble size varies following absolute water pressure. The discussers' measurements indicate that very high air concentrations can be reached at jet impact into a water cushion, but that typical air concentrations are only between 2% and 8% at the jet stagnation point on the pool floor (Bollaert *et al.* 2009). Also, Bollaert (2002) and Bollaert and Schleiss (2003) measured air concentrations inside joints between artificial rock blocks at the pool floor. These were found between 1% and 10%, i.e. of the same order of magnitude as measured at the rock bed surface.

Finally, it was found that air in rock fissures can produce internal resonance dynamic pressures. Therefore, air can have a triggering effect on rock scour. Hence, the discussers point to the importance of using prototype values of jet velocities and pressures when determining the effect of air on scour. It is obvious that, if artificially aerating a low-velocity jet, air concentrations of 30–40% may be reached, not only at the point of jet impact in the water cushion, but also close to the pool floor stagnation point. Based on the discussers' high-velocity jet impact tests, however, this is only possible on a small-scale laboratory model, for which stagnation pressures remain low due to the small model scale.

To dissipate the apparent inconsistencies between the author's and discussers' models, all relevant physical phenomena should be correctly parametrized. Although this seems challenging, the discussers encourage the author to continue advancing a complete understanding of the complex scour problem in plunge pools.

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